SECTION 16501
LIGHTING CONTROL SYSTEM
(AUDITORIUM)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. This section includes the following lighting controls equipment:
   1. Auditorium lighting control system.

B. Related Sections: The following sections contain requirements that relate to this section:
   1. Section 16111, “Conduit and Fittings”
   2. Section 16120, “Building Wire and Cable 600 V and Below”
   3. Section 16127, “Splices and Terminations – 600 V and Below”
   4. Section 16131, “Boxes”
   5. Section 16191, “Supporting Devices”
   6. Section 16196, “Electrical Identification”
   7. Section 16160, “Panelboards”
   8. Section 16511, “Fluorescent Luminaries”
   9. Section 16512, “High Intensity Discharge Lighting”
   10. Section 16960, “Electrical Testing”

1.3 REFERENCES

A. National Fire Protection Association (NFPA)
   1. NFPA 70, 1999, National Electrical Code (NEC)

B. Underwriters Laboratories, Inc. (UL)
   1. UL 1008, 1996, Transfer Switch Equipment

C. Code of Federal Regulations (CFR)
   1. 47 CFR 15, 2000, Telecommunications Systems

D. Illuminating Engineers Society (IES)
   1. Lighting Handbook, 9th Edition

1.4 SUBMITTALS

A. Shop Drawings. Within sixty (60) days of receipt of order, the Manufacturer shall submit complete and at one time bound copies to the CM for approval prior to fabrication:
   1. Dimensions, components, and finishes of all equipment and accessories.
   2. All system assemblies and major sub-assemblies, cabinets, and enclosures, including notation of type and manufacture of switches, pilot lights, locks, hardware, and electrical and electronic connectors.
   3. Block schematics of system internal wiring and system element interconnection.
   4. Indication by boxed caption of any and all variations from contract Drawings and Specifications, whether or not these variations have been formally or informally accepted by the CM.

B. Final Submittal. Within thirty (30) days of final tests, and as a condition for final approval, the Manufacturer shall submit to the CM:
   1. Receipts for delivery of all non-installed items, i.e., all items designated, “deliver to CM.”
   2. Certificates of warranty, as set forth below.
   3. Three (3) bound sets to the CM:
      a. “As built and approved” drawings showing all systems and components as installed, including all field modifications.
      b. Operating and maintenance manuals.
      c. Parts lists.

1.5 QUALITY ASSURANCE

A. UL and NEMA Compliance: Provide equipment required as part of lighting control units that are listed and labeled by UL and comply with applicable NEMA standards.

B. Comply with NFPA 70 for electrical components devices and accessories installation.

C. Coordination: Coordinate layout and installation of lighting control system components with other installations.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment as factory-assembled modules with protective crating, padding, and covering.

B. Lift and support units with manufacturer’s designated lifting or supporting points.

C. Store equipment to prevent dirt, contamination, and moisture from entering enclosures.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate location of heavy equipment with wall bracing and construction to facilitate equipment mounting.

1.8 WARRANTY

A. The Manufacturer shall unconditionally warrant all equipment and systems provided under this Section to be free from defects in materials and workmanship for a period of at least two (2) years from the date of final acceptance of all work of this Section. Lamps and normal wear and tear are exempted.

B. Appropriate additional equipment to replace equipment removed for service shall be provided at the job site at no expense to the Owner to replace any and all equipment that must be removed for service. Replacement control panel(s) must of the same model as those removed for service.

C. Warranty service shall be performed by personnel in the employ of the Manufacturer and shall not be sub-contracted or assigned to another company, service, or individual unless the Construction Manager has approved such assignment in writing, in which event the Manufacturer shall nevertheless be responsible to the Owner for such work.

1.9 SERVICE AVAILABILITY

A. For a period of five (5) years following acceptance, the Manufacturer shall maintain service capability by guaranteeing a factory-authorized representative available for on-site service calls within twenty-four (24) hours of notification by Owner of a need for service.

PART 2 - PRODUCTS

2.1 GENERAL

A. All components shall be new, in good condition, and under warranty.

B. All components shall bear UL labels and labels identifying the manufacturer, model number, and serial number. All such labels shall be permanently attached in a conspicuous location.

C. The entire control system shall be the responsibility of a single manufacturer unless otherwise approved in writing by the Construction Manager.

D. All control, signal, and video connectors shall be of substantial construction and shall be of the locking or latching type.

E. Where specification allows for “approved equal,” substitutions shall be proposed to the Construction Manager at least ten (10) days prior to bid date.

F. Equipment manufactured by any of the following companies which equal or surpasses the performance and quality specified will be acceptable:
   1. Electronic Theater Controls, Middleton, Wisconsin

2.2 SYSTEM OVERVIEW

A. Normal operation of the system shall be via an LCD-style Main Architectural Controller (LCD), which shall be used to program the system and provide all playback commands. It shall also be possible to select and activate presets using the Entry Panel (EP) and Preset Selector panels (PS). A Theatrical Lighting Console shall connect to the system via Control Receptacle Panels (RCP) in the control booth and on stage. The system shall function as follows:
   1. The two Stage Preset Selector Panels (S-PS)-one in the Control Booth and one on the Stage-shall affect only lighting for the Audience Chamber and shall function on “a last action takes precedence” basis.
   2. The two House Preset Selector Panels (H-PS)-one in the Control Booth and one on the Stage-shall affect only lighting for the Audience Chamber and shall function on “a last action takes precedence” basis.
   3. It shall be possible for an operator in the Control Booth to “lock out” the functionality of the Stage and House Preset Selector Panels on the stage and the Entry Panel.
   4. The Theatrical Control Console shall function on a “pile on” basis with all other panels.

2.3 MAIN ARCHITECTURAL CONTROLLER (LCD)

A. The panel shall be flush wall mounted, deadfront, and completely wired internally, with terminals of the proper rating for all external wiring.

B. The face of the panel shall contain a rear-illuminated LCD panel and associated pushbutton switches for the programming and playback of channel assignments, channel names, preset levels, preset names, and fade duration times.

C. Panel shall be capable of controlling at least 192 dimmers on at least 96 control channels with at least 14 presets.

D. LCD Panel shall be able to recall at least 14 presets from actual unit.

E. Acceptable product lines:
   1. ETC “Unison” or approved equal.

2.4 THEATRICAL CONSOLE. The system described below is based upon general performance criteria common to the ETC “Express 48/96” system. No other system shall be considered unless specifically approved by the Construction Manager at least 10 days prior to bid date.

A. Physical requirements. The console shall be deadfront, modular in construction, with plug-in control components, completely wired internally, and shall contain, but not be limited to, the following components:
1. Keypad for patching, level setting, and cue recording.
2. Playback controls, including split crossfader.
3. Minimum twenty-four (24) submaster/backup potentiometers.
4. All control potentiometers shall be flat path, direct drive, and shall be scale calibrated from 0 to 10 in half steps.
5. Library storage for recording of all patch, submaster, and cue information.
6. Switch for power on and off.
7. Dimmer rack temperature warning light. Note: if warning light is not integral to the Control Console, provide separate panel containing warning light.
8. Locking connections for power and dimmer control. Control connectors shall be equal to 5-pin XLR, Switchcraft D5F. Smaller or less substantial connectors shall not be acceptable.
9. Output connections for at least one (1) DMX-512 signal universe.
10. It shall feature at least 192 Channels with a minimum of (96) channel submasters.

B. Operational requirements.
1. Dimmers shall be electronically assigned to control channels by means of a keypad.
2. Dimmers shall be electronically assigned to backup controllers by means of a keypad.
3. Channels shall be electronically assigned to submasters at proportional levels by means of a keypad.
4. Channel levels shall be set and adjusted by means of a keypad.
5. Cues shall be recorded, along with fade times and sequencing, by means of a keypad.
6. Cues shall be played back manually or automatically by means of a split crossfader.
7. It shall be possible to dynamically override and modify a cue playback.
8. It shall be possible to play back prerecorded special effects.
9. The internal (RAM) memory shall store at least 600 cues.
10. Pile-on crossfades and overlapping scenes shall function on a highest-level-takes-precedence basis.
11. In the event of a loss of power, an internal battery backup power supply shall hold all memory information for up to 24 hours.
12. The control output signal shall be multiplexed and shall require no more than eight (8) conductors.

C. In single-channel mode, the Control Console shall provide at least 96 control channels and at least 512 dimmers (one universe of DMX signal).

D. In two-scene preset mode, the Control Console shall provide at least 48 channels.

E. In single-scene preset mode, the Control Console shall provide at least 96 channels.

F. Console shall include:
1. One (1) set of 25-foot multi-conductor control cables terminating in locking connectors appropriate for mating with the Control Receptacle Panel.
2. Vinyl dust covers for the console.

2.5 ENTRY PANEL (EP)

A. The Entry Panel (EP) shall be recess mounted, deadfront, and completely wired internally, with terminals of the proper rating for all external wiring. The face of the panel shall be recessed and covered by a hinged latching cover with a clear view panel.

B. The face of the panel shall contain pushbutton switches for the manual activation and de-activation of specified preset. The panel shall be labeled “LIGHTING” and the pushbuttons shall be labeled, “ON” and “OFF”.

C. Panel faceplates shall use no visible means of attachment and same color shall be available for faceplates and buttons (color by the Construction Manager).

2.6 PRESET SELECTOR PANEL (S-PS)

A. The preset selector panel shall be flush wall mounted, with all exposed trim finished to color as selected by the Contract Manager. Panel faceplates shall use no visible means of attachment (coordinate with audio visual equipment in field).

B. The face of the panel shall contain ten (10) programmable pushbuttons to select presets 1 through 9 plus an OFF button.

C. Panel shall be labeled “STAGE LIGHTS” and preset buttons shall be permanently labeled on the face plate 1 through 9 and OFF accordingly.

D. Panel faceplates shall use no visible means of attachment and same color shall be available for faceplates and buttons (color by the Construction Manager).

2.7 PRESET SELECTOR PANEL (H-PS)

A. The preset selector panel shall be flush wall mounted, with all exposed trim finished to color as selected by the Construction Manager. Panel faceplates shall use no visible means of attachment (Coordinate with audio visual equipment in field).

B. The face of the panel shall contain five (5) programmable pushbuttons to select presets 1 through 4 plus an OFF button.

C. Panel shall be labeled “HOUSE LIGHTS” and preset buttons shall be permanently labeled on the face plate 1 through 4 and OFF accordingly.

D. Panel faceplates shall use no visible means of attachment and same color shall be available for faceplates and buttons (color by Construction Manager).

2.8 CONTROL RECEPTACLE PANEL (RCP1)

A. The control receptacle panel shall be flush wall mounted (Coordinate with audio visual equipment in field).

B. Panel shall contain (1) locking receptacle for the connection of a lighting control console. Receptacle and wiring shall be compatible with DMX512 protocol.

2.9 CONTROL RECEPTACLE PANEL (RCP2)

A. The control receptacle panel shall be flush wall mounted (Coordinate with audio visual equipment in field).

B. Panel shall contain (1) locking receptacle for the connection of a lighting control console. Receptacle and wiring shall be compatible with DMX512 protocol.

C. Panel shall contain (1) locking receptacle for the connection of a hand held remote.

2.10 RS-232-C INTERFACE PANEL

A. The panel shall interface between data terminal equipment and data communications equipment employing serial binary data interchange. See Audio Visual spec.

2.11 DIMMER RACK

A. Physical Requirements.
1. The Dimmer Racks shall be floor supported, deadfront, substantially framed, and enclosed with sheet metal panels. Access for installation and maintenance shall be provided through the front of the rack. All parts shall be properly cleaned prior to painting and then painted with a rust inhibiting primer. The finish paint shall be baked enamel. Each rack section shall not exceed 30" wide, 30" deep, and 84" high.
2. The racks shall be mounted on waffle type neoprene vibration padding, Mason Industries type W, with a hardness of 40-50 Duro. Each corner of each rack shall contain two (2) pads mounted back-to-back and attached to a steel plate to distribute the load from the corner of the frame.
3. All connections and test points shall be accessible through the front of the rack.
4. The rack shall incorporate a front locking door to cover all user-operable portions of its components.
5. Provide Control signal output receptacle, to allow additional dimmers to be added on the same control chain.

B. Electrical Requirements.
1. The Dimmer Racks shall be designed to operate at a voltage of 120/208 volts, 60 Hz, 3-phase 4-wire, with the main busses of each rack sized for maximum full loading of all contained dimmers.
2. The Dimmer Racks shall be completely wired internally, and terminals of the proper rating shall be provided for all external connections. Each terminal shall be clearly and permanently marked and numbered.
3. Each circuit card space shall include a factory wired multi-conductor connector to allow insertion and withdrawal of the circuit card.
4. In order to protect control components from a catastrophic failure of voltage isolation at the dimmer module, the Dimmer rack shall incorporate additional isolation between control voltage of all control devices and line voltage of dimmers. Isolation shall be in excess of 2500 volts RMS. This isolation shall be in addition to any isolation provided in each dimmer. If dimmer rack includes a control signal output receptacle, isolation shall be incorporated to protect the control signal leaving the rack.

2.12 DIMMERS

A. Dimmers shall be fully solid state, utilizing silicon controlled rectifiers (SCR) in a back-to-back electrical configuration which provides, at all times, a symmetrical alternating current output. The full load of the circuit shall be carried and controlled solely by the SCRs; or shall use an IGBT capable of symmetrical forward and reverse phase control.

B. Dimmers shall be designed to operate within a normal ambient temperature of 0 degrees C. to 40 degrees C. and in normal relative humidities of 20% to 90% with no adverse effects.

C. Dimmer shall accept any "hot patched" load within its rating with the controller at any brightness.

D. The output voltage versus control position (curve) shall be factory adjusted to conform to the IES square law dimming curve.

E. Response time shall not exceed 4 cycles (1/15 second) for dimmers.

F. Response time shall not exceed 10 cycles (1/6 second) from the activation of any non-dim controller (e.g., pushbutton, console channel) to the output of FULL at the non-dim module.

G. Power efficiency shall exceed 95% at any voltage and at any load.

H. Full load output voltage shall be within 6 volts RMS of line voltage with the controller at full.

I. Each dimmer shall include an integral inductive toroidal filter to reduce the rate of current rise resulting from the SCR switching, to isolate the dimmer from the AC line to prevent interaction with other dimmers, and to limit conducted radio frequency interference.

J. Isolation between the AC line and control circuit shall be in excess of 2500 volts RMS.

K. Provide and install dimmer quantities as shown in the Drawings and Schedules.

L. Each dimmer space and circuit card space shall be clearly labeled with circuit/dimmer number and circuit card identification.

M. Dimmers rise time shall not be less than 500 microseconds measured at 90 degree conduction angle, at the dimmer's full rated load.

N. Acceptable product lines:
   1. ETC "Sensor"

2.13 EMERGENCY DIMMER TRANSFER

A. The Emergency Dimmer Transfer shall be designed to operate at a voltage of 120/208 volts, 60 Hz, normally fed from the building emergency system.

B. The operation of the Emergency Dimmer Transfer shall be as follows:
   1. The transfer switch shall employ integral "break-before-make" relays to switch power to the emergency lighting circuits between the normal stage dimmer feed and the emergency feed.
   2. The transfer shall incorporate relays that shall transfer the power to the emergency lighting circuits to the emergency power system if the power feed to the Dimmer Rack is interrupted.
   3. The transfer shall include a power sensing circuit to determine when power to the Dimmer Rack has been interrupted. In the event of a power interruption, the transfer shall automatically reset power to the emergency lights through the emergency dimmers.
   4. The transfer shall comply with the safety standards of NASI/UL 1008 rev.5 and ANSI/NFPA 70 (NEC Articles 700 and 701).

C. Install as shown on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in for lighting control equipment and verify that construction is in accordance with manufacturers recommendations and ready for installation.

B. Examine walls, floors, and cabinets for suitable conditions where equipment is to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install all items in conformity with standard trade practices and Manufacturer's recommendations.

B. Consult and coordinate work with trades doing adjoining work.

C. Position all items accurately as indicated in the Drawings, and true to plumb line and level. Maintain maximum headroom and clearance at all points.

3.3 FIELD QUALITY CONTROL

A. Verify that installed light fixtures are of the type compatible with the control system.

B. Check that equipment is complete with trim, covers, fittings, and other specified components.

C. Inspect installed equipment for damage. Replace damaged components.

3.4 TESTING AND INSTRUCTION

A. Upon completion of all installation work, the Contractor shall certify in writing to the Construction Manager that the work is complete and ready for final inspection. Final inspection shall be scheduled by the Construction Manager within fourteen (14) days following the Contractor's notice of completion.

B. The Manufacturer's factory trained technician shall inspect the completed installation and recommend adjustments and modifications as required.

C. After system checkout and adjustment, the Manufacturer's factory trained technician shall operate the system for the approval of the Construction Manager.

D. At this time, a knowledgeable representative of the Manufacturer shall instruct the Owner's staff in the operation and maintenance of the system. This instruction session shall be scheduled to last a minimum of three (3) hours.

3.5 ADJUSTING

A. Operate and adjust controls. Replace damaged and malfunctioning controls.

3.6 CLEANING

A. Clean fixtures and controls with manufacturers' recommended cleaning methods and materials.

3.7 PROTECTION

A. Provide protective covering for installed equipment to prevent damage resulting from continuous construction activities.

END OF SECTION 16501